IDENTIFICATION OF MEGACITIES AND THEIR VERTICAL AND HORIZONTAL CLASSIFICATION IN THE PERIOD FROM 1950 TO 2050

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ABSTRACT

As a result of its explosive rise since the second half of the 20th century, the population of the world has tripled in comparison with 1950. In 2009, the number of inhabitants living in cities was over the number of people inhabiting rural areas, while from 75 in 1950 the number of cities with more than 1 million inhabitants is expected to increase to 553 by 2050. Nevertheless, the most evident forms of the march of urbanization are megacities, i.e. those urban agglomerations where extremely large populations are concentrated. One important problem of defining megacities is the determination of an optimum population threshold that is the establishment of the population value over which an urban agglomeration can be regarded to be a megacity. This article has been divided into two main sections: the first section relies on a relatively objective method to determine the optimum population threshold value of megacities, whereas the second section makes use of the World Bank and UN's country classification to arrange the same cities into groups. With the help of the various classifications, the vertical and horizontal shifting of megacities in the period from 1950 to 2050 becomes clearly apparent.

Keywords: *megacity, population threshold, The World Bank country classification, UN country classification*

1. INTRODUCTION

Megacities are the most evident resulting forms of process of urbanization (UN, 2010), and their development is continuously monitored by international organizations (United Nations, The World Bank) and the governments of nation states. Today, in parallel with the huge population rise in the developing world, the location of newborn megacities also continuously shifts from the direction of the developed and traditionally urbanized North America, Europe and Japan primarily towards Africa, South Asia and Southeast Asia (Kraas, 2007). It can be regarded as a general problem, however, that the associated technical literature on the one hand, while on the other hand international organizations consider different parameters when determining megacities, while the establishment of the population threshold is rather uncertain over which urban agglomerations can be called megacities.

It is this very uncertainty that seems to be the reason why a kind of consistent vertical and horizontals shift, i.e. the direction of the spread of new megacities can be detected. This study stands on a relatively objective basis when defining the lower population threshold value for megacities (indeed the concept of megacity itself), and describing their course of development in view of the changes in their populations in the period from 1950 to 2050. As the UN provides estimates for the population of urban agglomerations – in fact all the cities with more than 750,000 inhabitants – only until 2025, for the period of 2025–2050 we have relied on our own calculations to determine the necessary number of inhabitants. The second part of this study makes use of the World Bank (per capita GDP) and UN's country classification (geographic regions) to show the directions of vertical and horizontal shifts for megacities in the period from 1950 to 2050.

2. DETERMINATION OF MEGACITIES

In the definition of megacities, fundamentally two critical factors can be detected: first the population threshold over which the given urban agglomeration can be regarded to be a megacity, and second the territorial demarcation of the urban agglomeration that also includes the metropolis identified as the megacity. In fact, both problems lie on fairly subjective foundations, and for this very reason their preliminary examination can be considered as substantial and unavoidable.

2.1. Territorial demarcation of megacities

Naturally, the most important question in the identification of megacities is the clear definition of the lower population value, while on the other hand it unavoidably needs to be clarified which urban agglomerations can be defined as megacities. For these researches, one of the key documents and databases is the UN World Urbanization Prospects (WUP) publication, which has been following the population of cities since 1950, and offers medium-term estimates, now until 2025 (UN, 2010). According to WUP, in 2010 the most populous urban agglomeration of the world was Tokyo with a total population of 36.67 million, where New York, which used to top the list for long, but tanked only sixth in 2010, had 19.43 million inhabitants. However, the question is what territorial units Tokyo or New York covers? The analysis of the example of these two metropolises clearly sheds light on the general territorial demarcation that UN applies to every city.

2.1.1. Example 1 - Tokyo Major Metropolitan Area

Today's Tokyo, or Tokyo Metropolis as it is officially known, was formed in 1943, when Tokyo City consisting of 23 wards and Tokyo Prefecture surrounding the city were united. According to the 2010 census, the population of the former Tokyo City was 8.95 million, while the number of inhabitants in Tokyo Metropolis or Tokyo reached 13.05 million. From the areas lying in the surroundings of Tokyo Metropolis, the Japan Statistics Bureau has established several functional regions (One Metropolis, Three Prefectures, Kantō Major Metropolitan Area, Tokyo Major Metropolitan Area, National Capital Region) by considering various aspects of arrangement, and one of these regions has come to be the *Tokyo Major Metropolitan Area* identified as the Greater Tokyo Area. This region includes all the settlements within the 70 km range of the Tokyo Metropolitan Government Building standing in the Shinjuku ward of the Tokyo Metropolis, and thus such specific cities as Chiba (962,000 inhabitants), Kawasaki (1,426,000 inhabitants), Sagamihara (718,000 inhabitants), Saitama (1,223,000 inhabitants) and Yokohama (3,690,000 inhabitants). On the whole, it means that in UN's interpretation Tokyo does not cover the actual city, Tokyo Metropolis, but the Tokyo Major Metropolitan Area, which has nearly three times as large a population as the city. The largest Japan cities, such as Osaka and Nagoya are typically surrounded by similar metropolitan areas.

2.1.2. Example 2 - New York–Northern New Jersey–Long Island MSA

In the United States of America, the Metropolitan Statistical Area (MSA) as a regional unit has been shaped by the Office of Management and Budget, and is used by the U.S. Census Bureau principally in the field of statistics. The MSA has been established in order to demarcate the urban zones that feature relatively high population densities, form closely related units in economy, and are centered by their own, dominant metropolises. The largest MSA is *New York–Northern New Jersey–Long Island*, which – in addition to the central urban unit, New York City with its population of 8.18 million (US Census, 2010) – has such components as 10 counties from New York State, 12 counties from New Jersey and one from

Pennsylvania. Often identified as the New York Metropolitan Area, Metropolitan New York or Greater New York, this territorial unit of nearly 20 million inhabitants in effect corresponds to the New York–Northern New Jersey–Long Island MSA. In 2010, the United States of America boasted of 366 MSAs, of which the largest ones were the New York–Northern New Jersey–Long Island MSA (19.43 million inhabitants), the Los Angeles–Long Beach–Santa Ana MSA (12.76 million inhabitants) and the Chicago–Joliet–Naperville MSA (9.20 million inhabitants) with areas overarching different states, while the smallest one was Carson City with a population of just cc. 55,000.

2.2. Population threshold of megacities

Territorial demarcation can be regarded to be a relatively constant state, and thus the above-mentioned examples only highlight the methodology used in international practices. A much more critical question is the determination of the lower population threshold of megacities, because international organizations (United Nations, The World Bank) and experts concerned in the relevant research topics alike tend to define the various population threshold values on the basis of is subjective criteria. The UN (2006; 2008; 2010) is consistent in regarding the 10 million population to be the appropriate population threshold, while in contrast some researchers of the topic have arrived at very different values: according to Dogan and Kasarda (1988), the lower limit should be 4 million, for Kraas (2011) it is 5 million, Richardson (1993), Gilbert (1996) and Silver (2008) regards it to be 8 million, while Ward (1990) has opted for 10 million. In order to eliminate this subjectivity to a certain extent, we have reconceived the population threshold value needed for the identification of megacities: in our opinion, it is the urban agglomerations with populations larger than the arithmetic mean of the total population of the 100 most populous metropolises from time to time that can be regarded as megacities. This statement is valid for any year, and moreover the rationale underlying this approach is to make long-term changes appropriately and logically traceable. In this methodology, obviously, a subjective element is the establishment of the number of the examined urban agglomerations (which is 100 in our case), while sources focusing on megacities are relatively novel, and there are no population threshold values available back to the 1950s in retrospect. The population threshold values we have determined and the number of megacities are shown in *Table 1*. It is apparent that since 1950 the population threshold – in parallel with the populations of the cities – has been on a continuous rise, while the number of megacities has not reflected a straight-line growth. One underlying reason is that the increase of the populations in the most populous megacities has come to be over the average, which strongly influences the critical population threshold value: the larger the top-ranking megacities are, the larger values the population thresholds take, i.e. there are fewer agglomerations that can pass the limit. By 2045, the value of the population threshold may reach 10 million – in 2050 it will pass this limit –, but the theoretically defined population threshold values do not exceed 10 million in any of the cases, and therefore it is regarded to be an ideal minimum value.

Table 1: The lower population threshold and number of megacities on the basis of the populations of the 100 most populous urban agglomerations (1950–2050)

	1950	1960	1970	1980	1990	2000	2010	2020	2030	2040	2050
Population threshold of megacities (million inhabitants)	1.99	2.63	3.39	4.20	5.10	6.25	7.47	8.53	9.37	9.98	10.00
Number of megacities	25	25	27	31	29	34	34	36	34	35	35

Obviously, both the population threshold and the number of megacities may vary as depending on the methodology used for the determination of the tendency of population

increase or decrease as the case may be. Our calculations have assumed the simplest case, i.e. the parallel change of the population, and therefore our basic suggestion has been that after 2025 the growth rates of the populations of metropolises will correspond to the growth rates of the populations in the respective countries. Changes in the populations of these countries have been determined on the basis of the U.S. Census Bureau's data series for the period between 1950 and 2050. The populations of the cities are published in the UN (2010) World Urbanization Prospects, where data are provided until 2025. The populations of the megacities (and in fact all the cities with more than 750,000 inhabitants) have been calculated further for the future on the basis of the changes in the population of the respective countries in 2025–2050. It means that the rates of change in the populations of megacities (either increase, or decrease, as the case may be) correspond to the change in the populations of the countries where these cities are situated.

3. MEGACITIES

The population of megacities – in parallel with the general demographic trends – is on a steady rise, and so far has increased from 108 million in 1950 to 608 million in 2050. On the other hand, this population growth trend in megacities cannot be regarded to be outstandingly high, because in the case of cities with more than 1 million inhabitants the growth rate of the population is much higher, nearly double of the growth rate of the population in megacities (*Figure 1*). The total population of the two categories is obviously and basically determined by the number of cities included in these two categories. The average population presented in *Figure 2* shows that the average population of megacities will have been quadrupled between 1950 and 2050 from 4.34 million to 17.37 million, while the average population of cities with more than 1 million inhabitants will have risen to a 1.5-fold value in the same period. The number of cities with more than 1 million inhabitants will have been on a steady and considerable rise since 1950 up until 2050, while the average population will not change significantly, while the number of megacities will increase at a relatively slow pace, or even stagnate (which is a consequence of the method of their definition), while their population will see some rapid growth. According to the figures of the UN (2010), by 2050 the world population may be up to 9.1 billion, of which 6.4 billion people will be living in cities; 34% of these people will belong to cities with more than 1 million inhabitants, whereas nearly 10% will live in megacities.

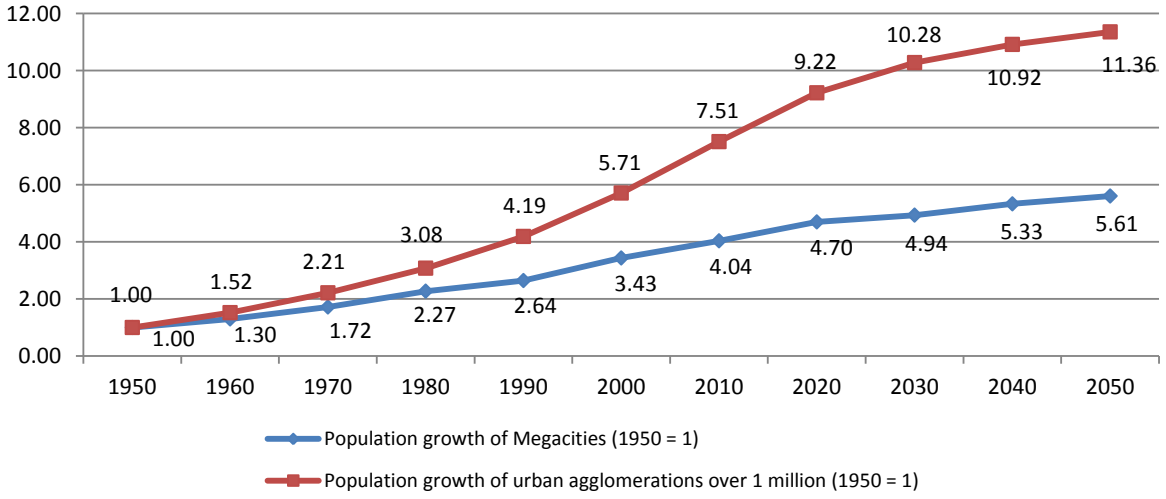

Figure 1: Growth rate of the population in megacities and cities with more than 1 million inhabitants between 1950 and 2050

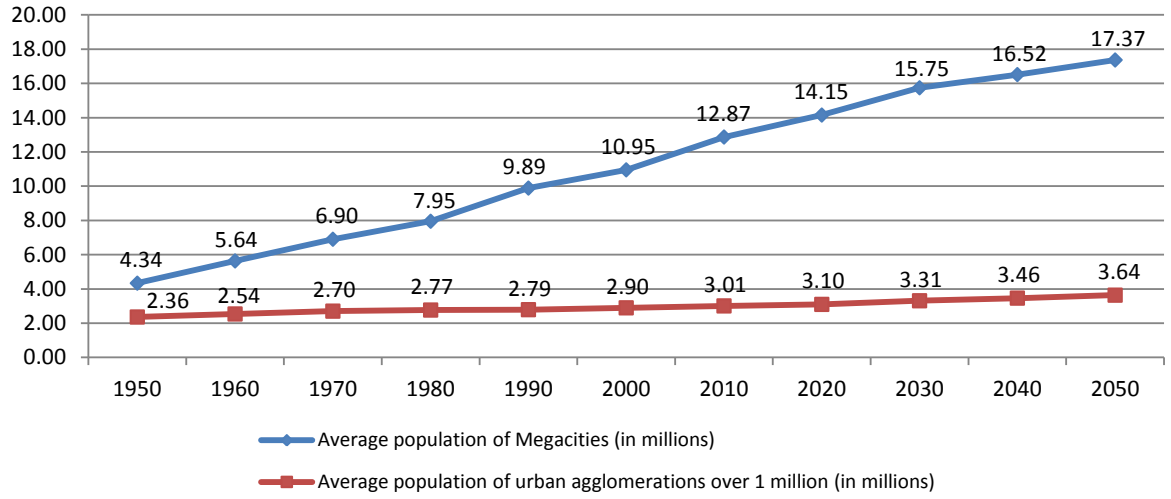

Figure 2: Changes in the population of megacities and cities with more than 1 million inhabitants from 1950 to 2050

In 1950, the most populous city worldwide was New York with 12.34 millions of people, after taking over the top of the rank from London, which had been the leading city for decades since the early 20th century (Chandler 1987). In the middle of the 1950s, the Japanese capital, Tokyo came to rank first, and will have remained the largest megacity for about a century. According to the forecasts, from the middle of the 2040s the rapidly growing Delhi in India will become the most populous city of the world. Tokyo's extreme position was the strongest in the middle of the 1990s, its nearly 33 million inhabitants was 16.5 million ahead of the second-ranking New York.

Until 2025, Tokyo's population will further rise until 2025 to reach the expected maximum, 37.1 million people, but from that time – in parallel with the dropping population of Japan – the population of the capital will also reflect a decreasing tendency. On the other hand, due to the explosive rise of the population of the cities on South Asian countries the gap between Tokyo and the following cities will steadily become narrower. As a result of the process, in 2050 Delhi will take over the leading role from Tokyo, and in addition Mumbai will also approximate Tokyo in terms of population (*Table 2*).

In the ranking of megacities, the largest extent of fallback will not belong to Tokyo (though it is undoubted that the nearly 5 million, absolute decrease of the Japanese capital in comparison with the maximum population is the largest drop among megacities), but Germany's capital, Berlin. *Table 2* shows that in 1950 Berlin used to be the 12th most populous metropolis with its population of 3.34 million, and moreover according to Chandler (1987) it had ranked 4th back in 1900, but by 2050 its population will have shrunk to 3.16 million, and thus will be only the 169th in the ranking. By 2050, the only European megacity – irrespective of Istanbul listed by UN as belonging to West Asia – will be the 31st Paris.

Table 2: The 15 largest megacities of the world in 1950, 2000 and 2050

Rank	Megacity	Population (million inhabitants)	Megacity	Population (million inhabitants)	Megacity	Population (million inhabitants)
	1950		2000		2050	
1	New York	12.34	Tokyo	34.45	Delhi	33.90
2	Tokyo	11.28	Mexico City	18.02	Tokyo	32.23
3	London	8.36	New York	17.85	Mumbai	30.63
4	Paris	6.52	São Paulo	17.10	Lagos	27.15
5	Moscow	5.36	Mumbai	16.09	Dhaka	26.49
6	Buenos Aires	5.10	Delhi	15.73	New York	24.82
7	Chicago	5.00	Shanghai	13.22	São Paulo	24.34
8	Kolkata	4.51	Kolkata	13.06	Kolkata	23.87
9	Shanghai	4.30	Buenos Aires	11.85	Karachi	23.85
10	Osaka-Kobe	4.15	Los Angeles	11.81	Mexico City	23.53
11	Los Angeles	4.05	Osaka-Kobe	11.17	Kinshasa	21.96
12	Berlin	3.34	Rio de Janeiro	10.80	Manila	19.90
13	Philadelphia	3.13	Dhaka	10.29	Shanghai	18.71
14	Rio de Janeiro	2.95	Cairo	10.17	Cairo	17.98
15	Saint Petersburg	2.90	Karachi	10.02	Los Angeles	16.45

Nevertheless, the most dynamic rates of population growth are not reflected by the cities of South Asia, but Chinese and African cities. From 1950 to 2050, the largest population growth rate will be brought about by Shenzhen in China, whose population will have changed from 3,000 to 10.4 million in the examined period. Yet, the population growth of cities in China and African countries is motivated by far much different causes. Within the framework of economic reform measures, in 1979 the Chinese government designated, and then in 1984 expanded the so-called Special Economic Zones (SEZ) to serve as driving forces for the growth of Chinese economy (Yueh 2010).

The majority of the Chinese cities reflecting the largest population growth is situated within these SEZ areas (such as Shenzhen, which was among the first areas to be designated), while their population growth was mostly influenced by migration within the country (Oborne 1986). In contrast with the Chinese cities, from the middle of the 20th century in the cities of the African countries population growth was primarily and typically driven by endogenous population boom: in the light of the UN's associated figures, Africa in 2000 accounted for only 13.4% of the world's population, while by 2050 it will have increased to 21.8%. In terms of proportions, all the other continents will show decreasing tendencies with the most typical example given by the most populous continent, Asia, whose share of population will decrease from 60.5% in 2000 to 57.2% in 2050.

4. VERTICAL (THE WORLD BANK) AND HORIZONTAL (UNITED NATIONS) CLASSIFICATION OF MEGACITIES

Obviously, the various parameters of megacities are worth examining independently, but no far-reaching conclusions can be drawn from the changes of the positions of the individual cities. For this very reason, the evaluation of the various city groups is an important topic, and can be implemented on the basis of the classifications of the international organizations in relation to countries. In our analysis, the megacities belonging to the various country groups have been evaluated with reliance on the country classifications of the World Bank and United Nations.

The classifications made by these two organizations have been regarded to be substantial, because they approach the classification of countries along different principles of

arrangement: the World Bank establishes country groups in view of the per capita income, while the United Nations considers the geographic regions to be the fundamental units. In the first case, megacities can be categorized vertically on the basis of the per capita income of the given country in the specific country groups, whereas in the second case horizontal categorization can be made with respect to the geographic classification of the countries.

4.1. Vertical classification of the megacities

On the basis of the 2010 value of the per capita income, the World Bank determines four groups:

- Low-income economies: countries where the per capital income is USD 1,005 USD or smaller (Afghanistan, Bangladesh, Democratic Republic of the Congo);
- Lower-middle-income economies: countries where the per capital income is in the range of USD 1,006–3,975 (Angola, Egypt, India, Indonesia, Iraq, Nigeria, Pakistan, Philippines, Sudan);
- Upper-middle-income economies: countries where the per capital income is in the range of USD 3,976–12,275 (Argentina, Brazil, China, Colombia, Iran, Mexico, Peru, Russia, Thailand, Turkey);
- High-income economies: countries where the per capital income is USD 12,276 or larger (France, Germany, Japan, Republic of Korea, Spain, United Kingdom, United States).

It is important to emphasize that the World Bank's classification used in our analysis is valid only for 2010, and thus the historic and future figures have also been determined on the basis of the year of 2010. The underlying reason is that the World Bank publishes data series only for the time interval from 1987 to 2010, while for the future no relatively accurate estimates – at least for the GDP – are available.

Figure 3 shows that in 1950 it was the megacities belonging to high-income economies (HIE) country group that used to have the largest populations, but in 2050 they will rank only third with gradually decreasing populations from 2020. In 2050, megacities (New York, Los Angeles, Chicago) belonging to the HIE group will be represented only by three cities of increasing population in North America, Tokyo with its sharply dropping population and Paris with a steady number of inhabitants. The rise of the population of the American cities indeed counterbalances the decrease in the population of Tokyo and Paris, yet the number of megacities belonging to the HIE category will have diminished from 13 in 1950 to just five in 2050, while the dropout of the individual cities from the circle of megacities can potentially reduce the total population of the category by millions of inhabitants.

Megacities belonging to the lower-middle-income economies (LMIE) category reflect a process that is the opposite of changes in the HIE group. Back in 1950, the LMIE category was represented among megacities only with three cities with an aggregate population fewer than 10 million inhabitants, which was smaller than the population of New York alone at that time. On the other hand, in 2000 and 2050 nine and 15 megacities did and will drop out from the LMIE group, respectively, including six cities in India. *Figure 4* shows that in 2010 this group overtook the overall population of the megacities of the HIE group, and in the early 2030s it will go on ahead of the total population of the megacities belonging to the category of upper-middle-income economies (UMIE). This process is even more interesting when it is considered that in 2010 the World Bank reclassified China, and listed it to belonging to the UMIE group instead of the LMIE group, which has also been confirmed by our follow-up overview, meaning that since 1950 China has become categorized as an UMIE. Without the megacities of China (in 2050, five megacities with a population of 64 million), the UMIE group would be just shortly ahead of the HIE group. On the other hand, it is these Chinese

cities that contribute to the population decrease in the UMIE group to the largest extent. In 1950, following the HIE group the UMIE group ranked second in terms of the number of megacities, and reached the maximum in 2005 with 17 megacities (in that year, nearly half of the megacities belonged to the UMIE group), while in 2050 it will have again dropped to the second place with 12 megacities, behind the LMIE group. The decreasing number of megacities itself sets the shrinking of the total population of the UMIE group to be tendentious, yet the process is further reinforced by the fact that from 2025 – in parallel with the population of China – the populations of the Chinese megacities will turn into massive fallback. In the group of low-income economies (LIE), i.e. the poorest countries, the capital of Bangladesh, Dhaka was topping the rank, and became one of the megacities in the middle of the 1980s, and then in the middle of the 2000s Kinshasa (Democratic Republic of the Congo) closed up with Kabul (Afghanistan) rising considerably on the rank by 2050.

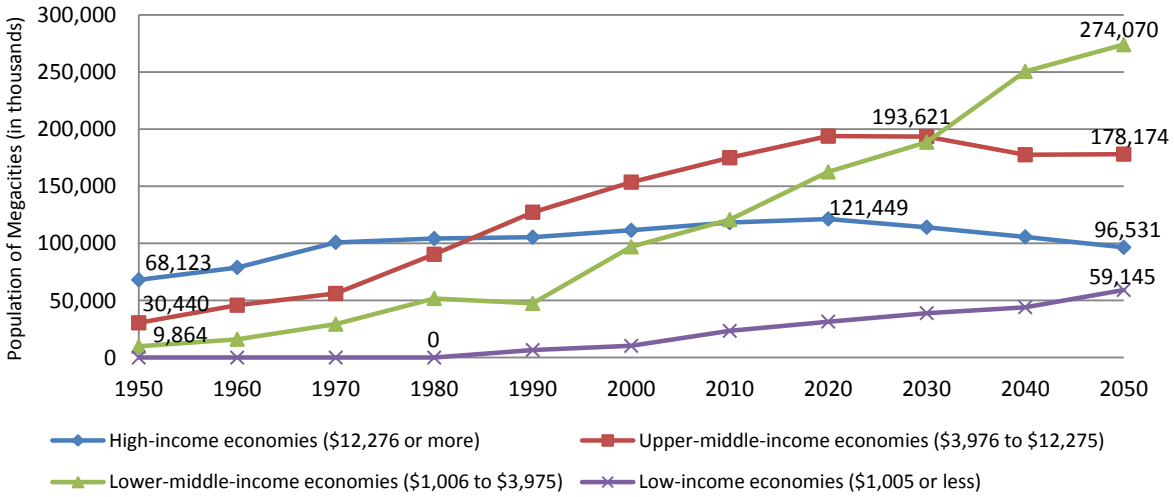

Figure 3. Changes in the population of megacities from 1950 to 2050 on the basis of the World Bank's classification

Figure 3 clearly shows that since 1990 the populations of the megacities in the LIE and LMIE countries with smaller per capita incomes have been sharply increasing (by more than 500 percent in the examined period), while from 2020 the populations of the megacities in the HIE and UMIE countries with larger per capita incomes will be strongly dropping (by 13 percent in the examined period). The analysis performed on the basis of the World Bank's classification suggests that in the period from 1950 until 2050 the number and population of the megacities have been gradually shifting from the direction of developed or more developed countries towards developing or less developed countries. In 2050, the low-income African, South and Southeast Asian countries will cover 55 percent of the total population of megacities.

4.2. Horizontal classification of megacities

Unlike the above analysis, UN does not classify countries on the basis of their economic performance, but places them into specific geographic regions. Nevertheless, the two classifications based on different methodologies lead to very similar results, which is true even if the number of basic units in the UN classification is far more than the number of the categories in the World Bank's classification.

Figure 4 shows that in 1950 the aggregate population of Europe's megacities exceeded 31 million (at that time, the largest number of megacities, i.e. seven megacities belonged to Europe), and then in the middle of the 1950s the megacities of the North American region came to top the rank. At the beginning of the 1960s, it was primarily the massive population growth of Tokyo and Osaka-Kobe, as well as the large Chinese cities (Shanghai, Beijing, Tianjin, Shenyang) that resulted in Eastern Asia taking over the leading role. Still another change is expected to come in 2030, when the total population of the megacities of Bangladesh, India and Pakistan in South Asia ranking only sixth back in 1950 comes on ahead of that of the Eastern Asian megacities. *Figure 5* also reflects that by the middle of the 2040s Eastern Asia will have been overtaken even by the megacities of the Latin American countries, though in this latter region population growth is not as considerable as in South Asia or the Sub-Saharan Africa. In comparison with the 2000 figures, by 2050 the largest – nearly 800 percent – increase in the population will have been brought about by the megacities of the Sub-Saharan Africa, which is partly explained by the rise in the number of megacities, and partly by the explosive increase of population in these megacities. In the period from 2000 to 2050, growth between 150 and 200 percent will have been produced by Northern Africa, Western Asia and South Asia, Northern America, Latin America and South-Eastern Asia will be increasingly slightly or fall back in stagnation, whereas in Eastern Asia and Europe the population of megacities will drop by 10 and 60 percent, respectively (in these latter cases, the number of the cities will also decrease).

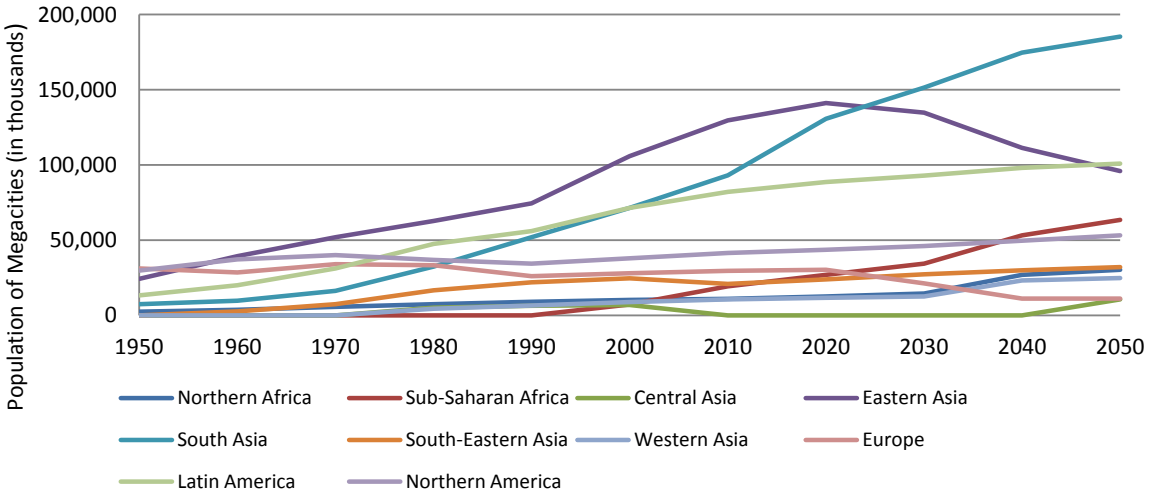

Figure 4: Changes in the populations of megacities in the geographic regions determined on the basis of the UN classification, 1950–2050

5. CONCLUSION

The first section of our publication has determined the optimum lower population threshold needed for the identification of megacities. We have started out from the assumption that the population threshold values established by the researchers studying this topic and international organizations are rather uncertain due to their subjective nature. For this reason, we have worked out a consistent terminology: those cities should be regarded to be megacities whose populations exceed the arithmetic mean of the number of inhabitants in the 100 most populous metropolises.

This method can be considered to be acceptable, because it excludes subjective elements, and can be applied to any period under review (at least where the appropriate data are available). However, UN has only such estimates that determine the populations of cities until 2025,

meaning that these estimates are valid only on the medium run. For this reason, the populations of cities have been calculated until 2050 with reliance on other sources of data, as based on the assumption that the populations of the cities and their respective countries will change in parallel with each other. This process has yielded data series for the period from 1950 to 2050. After the definition of the optimum lower population threshold and the populations of cities, megacities in the period of 1950–2050 have been named.

The second section analyzes the horizontal and vertical shifts in megacities on the basis of the United Nations and World Bank's country classifications. With respect to the per capita income, the World Bank determines four country groups, which allows the vertical classification of megacities, while the United Nations groups countries in geographic regions, which serves as the basis of horizontal classification. In the light of our results, in 2050 the large majority of megacities will belong to the less developed or underdeveloped countries and their populations will considerably exceed the number of the inhabitants in the individual megacities of the developed world. The dynamics of population growth show that in addition to the developing countries of South Asia (Bangladesh, India, Pakistan) it is primarily the populations of the megacities in the least developed Sub-Saharan Africa that will show explosive rise.

The results of this vertical and horizontal classification also suggest that in parallel with the increase of the per capital income the growth of population tends to stop, or even become reversed (e.g. China, Europe, Japan). According to Kraas (2008: 588), megacities are the key victims and causes of global natural and human risks at the same time. On the other hand, the number and populations of megacities increases in the less developed or underdeveloped countries to the largest extent, i.e. in the countries where presumably the smallest resources can be deployed for the prevention of natural and human risks.

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